Micro Autonomous Systems and Technology (MAST) Collaborative Technology Alliance:

Platform Integration

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Outline

Technical Area: Platform Integration

- Vision
- Challenges
- Example Research Issues
- Summary

Technical Area: Platform Integration

Understand and exploit the inter-platform and intra-platform interactions and efficiencies in a collaborative ensemble of microsystems to enable operational capabilities.

Integration Issues

- **Integration and experimentation are the keystone for generating empirical data, providing feedback to other Principal Members, and insuring the design process is iterative**
- **Radical design and engineering methodologies are envisioned in which system-level performance is emphasized over the optimization of individual functions**

The Principal Member for Integration
has primary responsibility for
articulating and executing
a vision on cross-Consortium integration.

Example Research Topics

Micro Autonomous Systems and Technology

Microsystem Mechanics

- Platform stability & control
- Low Reynolds number aerodynamics
- Bio-inspired sub-systems
- Propulsion and linear actuation
- .
- .
- .

Processing for Autonomous Operation

- Autonomous navigation and control
- Efficient information extraction and utilization
- Dynamic collaborative processing
- Cross-layer communications and network design
- .
- .
- .

Microelectronics

- 3D materials and circuit architectures
- Sensors and actuators for platform and payload
- Smart, multifunctional materials
- Low power devices and small electric power management
- .
- .
- .

Platform Integration

- Microsystem architectures, modeling, and design tools
- Experimentation and analysis
- Sub-system interactions
- Multi-functional packaging
- .
- .
- .

Technical foci

Technical Area: Platform Integration

- **Model, analyze, and simulate system performance**
- **Develop tools to design individual microsystem platforms and specify the collection of platforms necessary to achieve operational capabilities**
- **Study efficiencies that may be obtained through the integration of associated microsystem-related disciplines**
- **Integrate component technologies from Centers**
- **Collect empirical data, and validate platform and system operation through experiment**

The Impact of Architecture

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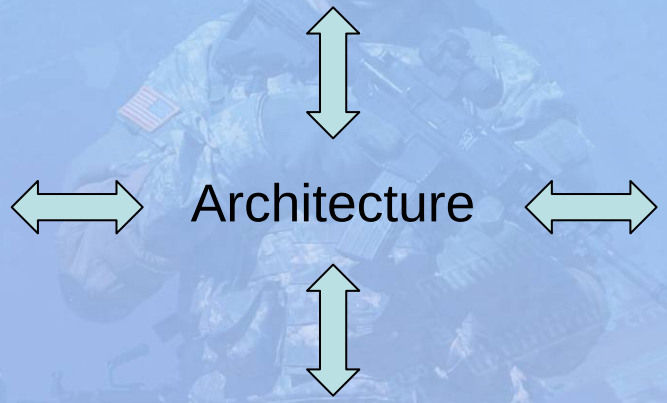
Affects behavior
Affects emergence

Affects one's ability to design, build, operate, diagnose, etc.



Affects complexity measures
Affects complexity barriers

Is the key to "ilities" such as flexibility, robustness, controllability

Architectural Challenges

Technical Area: Platform Integration

- **Balancing traditional against non-traditional engineering goals**
  - e.g., function, performance, cost vs. flexibility, robustness, scalability, controllability, programmability, sustainability
- **Determining the relationships between goals, characteristics, and structure**
  - Relationships or trade-offs are often the fundamental issues
  - e.g., performance vs. flexibility trade-offs
- **Managing complexity, uncertainty, emergence**

Example Research

- **Determine fundamental physical limits**
- **Define parametric representations of systems and subsystems**
- **Model system and subsystem interactions**
- **Develop design tools to examine tradeoffs**
- **Develop scalable system design**

Platform size, weight, and power dictate solutions that are not scaled versions of large platforms.

Experimental Challenges

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- **Integrating disparate technologies on a single platform**
- **Designing reliable experiments to validate parametric representations and models, and test assumptions on single and multiple platforms**
- **Analysis of empirical data to validate parametric representations and model**

Efficiency Challenges

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- **Balancing modularity against integration**
  - Needs and priorities for integration should be guided by anticipated gains in mission capabilities and should outweigh benefits gained through modularity
  - e.g., special purpose platform vs. plug-and-play payload
- **Balancing multifunctionality against single function performance**
- **Controlling negative effects of high density, heterogeneous integration**

Example Research

Technical Area: Platform Integration

- **Efficient structural shapes, materials, and multi-functional designs**
  - Functional packaging
  - Multifunctionality structures
- **Sub-system interactions**
  - Thermal management

Summary

Technical Area: Platform Integration

- **Integration across the Consortium**
- Develop tools to design individual microsystem platforms and to specify the collection of platforms necessary to achieve operational capabilities
- Validate platform and system operation through experiment
- Study efficiencies that may be obtained through the integration of associated microsystem-related disciplines such as functional packaging, multi-functional structures and materials, and sub-system interactions